Monitoring the Benefits of Instream Habitat Diversity

Entiat River, Chelan County, Washington

Bureau of Reclamation

Bonneville Power Administration

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This is an update of the report that first occurred in Columbia Basin Tributary Habitat Improvement: A Framework for Research, Monitoring and Evaluation (Appendix 1). January 2013. Bonneville Power Administration with assistance from the Bureau of Reclamation.

Introduction

The lower 16 miles of the Entiat River in north-central Washington State has seen a great deal of floodplain development and habitat simplification over the last 100 years. This floodplain encroachment and removal of large instream wood has largely resulted in a loss of instream habitat complexity without significant alteration to channel geometry, channel pattern, migration rates, pools, and, to a lesser degree, floodplain interaction.

This project is in an area where this reduced instream complexity has resulted in the loss of critical spawning, high flow refugia, and rearing habitat for several threatened and endangered salmonid species. In September 2007, the Milne Diversion Project was completed to improve spawning and juvenile rearing habitat quantity and quality to the river by reintroducing site-scale habitat features. Located between river miles 2.8 and 3.0 the goal of the project is to establish habitat diversity (Figure 1). Improved habitat diversity was envisioned to be accomplished through the addition of a variety of in-channel features, thereby increasing habitat complexity, increasing the availability of lost habitat types, and creating more dynamic habitats for three threatened and endangered species: Chinook salmon, steelhead, and bull trout. Features implemented in the project (Photos 1 – 4):

- *Barbs* (two types: bank-height and low-height) to promote deposition of bed load material that may be beneficial for spawning activities,
- *Rootwads* to provide cover and refuge, and
- *Boulder clusters* strategically placed in the main channel to modify the local hydraulic conditions creating velocity, depth, and substrate diversity (pocket pool habitat) as well as providing energy dissipation.

In 2008, the Pacific Northwest Research Station through the U.S. Forest Service embarked on an effectiveness monitoring program focusing on the Milne Diversion Project. Since construction, the team led by Polivka, has obtained three years of monitoring data 2009 and through 2011. Effectiveness monitoring is on-going. Polivka (2012) has concluded from preliminary results that habitat with structures is more beneficial for spring Chinook salmon and steelhead.

This report summarizes the monitoring and evaluation of the project at the microhabitat-scale as presented by Polivka (2010, 2011 and 2012). The monitoring data derived from the Milne Diversion Project is inferred at the reach scale by considering treated and untreated habitats within multiple reaches. This smaller scale monitoring and evaluation work complements the larger scale monitoring and evaluation being conducted by the Integrated Status and Effectiveness Monitoring Program (ISEMP) for the Entiat Intensively Monitored Watershed (IMW).

Project at a Glance

Formal Project Name: Milne Diversion	
Project Type: In-stream Complexity	
Project Sponsor: Cascadia Conservation District for planning and Chelan County Natural Resources Dept for Construction	
Project Design: Bureau of Reclamation (Baconguis)	
Partners: Various local landowners, U.S. Forest Service (Technical Assistance and Permitting), U.S. Fish and Wildlife (Project Development and Construction Oversight), and Bureau of Reclamation (Technical Assistance and Design)	**Reclamation Development Costs:** $153,000
Funding Source(s): Washington State Salmon Recovery Funding Board and the Tributary Fund	**Implementation Cost:** $97,000

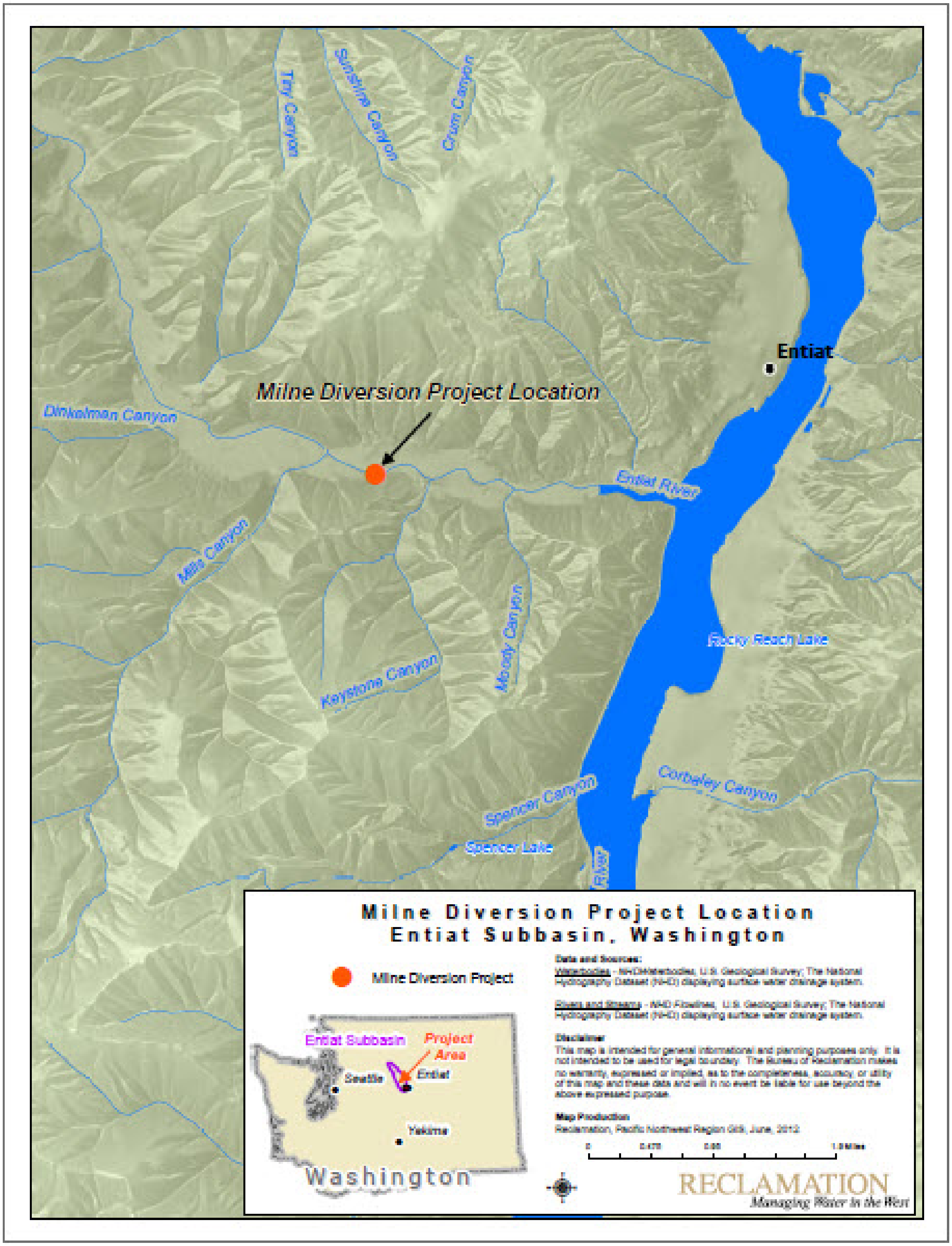


Figure 1. Location map of the Milne Diversion Project.

1)

2)

Photo 1. Two root wads keyed into the bank river right in the foreground and across the river on the left bank is a low-height diversion rock barb with sluice gate for a point of diversion at river mile 2.9. The river is moving to the east left to right.

Photo 2. Close up view of the same two root wads keyed into the bank river right from previous photo looking southwest down river with view around a bend in the river.


3)

4)

Photo 3. Low-height diversion rock barb on river left across from root wads shown in previous photos.

Photo 4. The view is southeast; entire view of site from previous photos showing adjacent orchard lands. Additionally contained downstream from previous structures is a boulder cluster (shown inside oval).

Methods for Monitoring and Evaluation

Monitoring and evaluation of the reintroduced instream habitat features is necessary to measure project success at meeting goals and forms the basis for adaptive management. Monitoring consists of both population size and individual growth and movement measurements within and among reaches. A paired reach scale monitoring design, one treatment and one control, is intended to complement the larger-scale effectiveness monitoring being conducted by ISEMP as part of the Entiat IMW. Monitoring by the Polivka team is being conducted to evaluate and test hypotheses related to installed instream habitat features:

1) Fish growth and movement would show density dependence.
2) Density dependence would differ between the treated and control reaches.

The project entailed the installation of five rock barbs, one diversion barb structure with sluice-gate, thirteen large logs with root-wads, and six mid-channel boulder clusters with five boulders each. The diversion barb will be used to convey water to the irrigation ditch and replaces the push-up dam created annually by the orchardist. The Polivka team specifically focused on monitoring the effectiveness of a series of four engineered log jams and five rock barbs within the 400-foot stretch of the treated reach and several other pool locations within the upstream control reach.

To verify whether fish were using the newly reintroduced habitat features and to gather population data, the field crews surveyed the river using two methods (Polivka, 2010) (Photo 5):

1) Snorkel surveys, and
2) Capturing, marking, and recapturing fish.

Ultimately, Chinook salmon and steelhead juvenile numbers were compared between microhabitats (pools) within each reach with and without added habitat features (Photo 6).

ISEMP conducted snorkel surveys and sampling of several habitat metrics considered important for channel complexity at the Milne site in 2007 and 2008. Specific parameters collected to support the Entiat IMW at the Milne site beyond juvenile fish density included 1) absolute thalweg depth; 2) standard deviation about the thalweg depth; 3) bankfull width-to-depth ratio; 4) pools (expressed as the percent of the site length containing pools); 5) substrate particle size expressed as D_{50}, and 6) substrate particle size expressed as D_{84} (meaningful size range of spawning gravels).

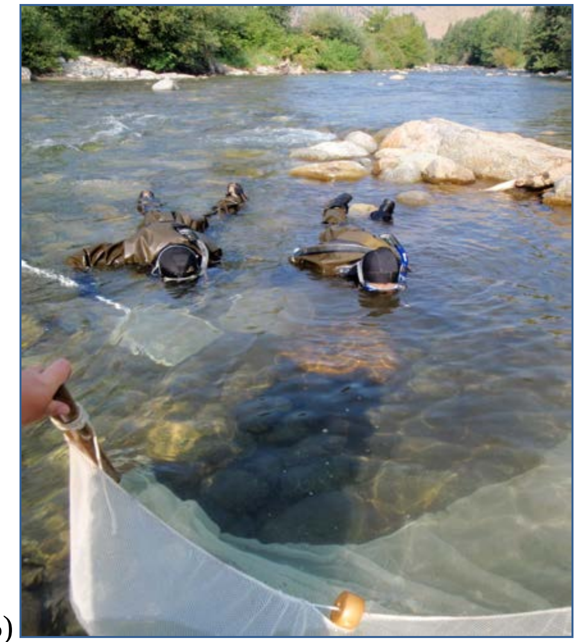
 5)  6)

Photo 5. A rearing wild spring Chinook parr, viewed during a snorkel survey in a pool behind a rock barb during summer 2009.

Photo 6. A crew in summer 2009 capturing fish downstream from a low height rock barb for mark-recapture studies (see Figure 5 on page 9).

Results, Interpretations, and Trends

Preliminary results from ISEMP indicate that fish densities increased at the Milne site; however, there were no appreciable differences in habitat metrics (Moberg and Ward, 2009). Of the six habitat metrics important for indicating changes to channel complexity sampled, several showed modest increases while the others very little. For example, microhabitat features at the Milne site did not create primary pool structures, but there were secondary pools created. Secondary pools are smaller than primary pools, which are defined as being wider than half the wetted channel width. Additionally, there was an increasing presence of larger substrate sizes evident from both large wood and rock placements. Conversely, conditions related to other metrics such as thalweg depth and bankfull width-to-depth ratio remained similar to control reach conditions.

Polivka (2011) has recognized from three seasons of monitoring, a number of observations regarding increased fish density associated with structure placements within the Milne reach segment of the lower Entiat River. In 2009, the survey crew observed the density of juvenile Chinook and steelhead in microhabitat pools created by the structures (blue boxes, Figure 2), finding a higher density in the early to mid-summer (July-August) compared to microhabitats sampled at random in this and several other reaches. The comparison also held true for microhabitats (see "Treated" in red, Figure 2) sampled randomly within the same reach where the created structures (blue boxes, Figure 2) were located.

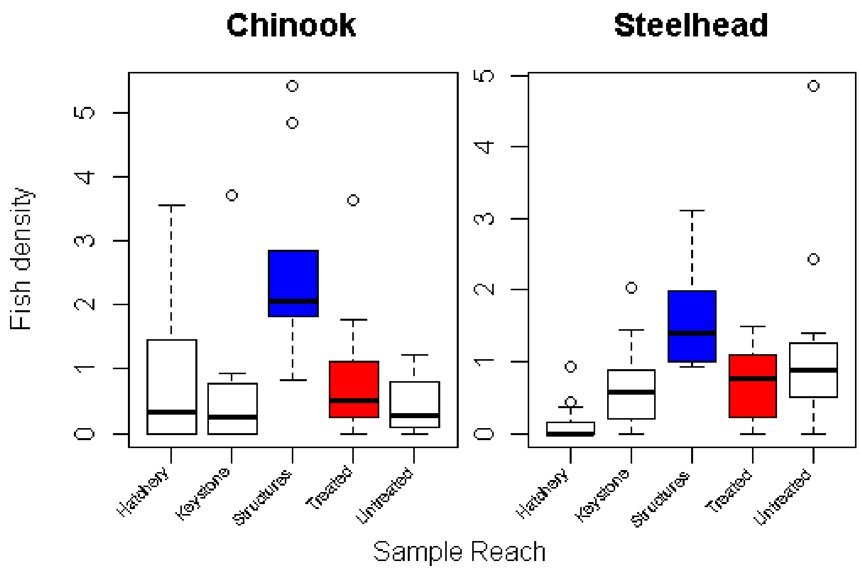


Figure 2. Fish density for Chinook salmon and steelhead at several locations within sampled reaches in early 2009.

However, later in the summer of 2009, fish density was not strongly associated with pool structures (not shown). This likely reflects the sub-yearling Chinook parr migration toward over-wintering habitat downstream and overall highly variable habitat selection patterns by steelhead. Furthermore, random censuses in the "Treated" reach showed higher steelhead density than at structures in the same reach. Delayed sampling in 2010 and 2011, due to high flows resulting from El Niño and La Niña events, respectively, reflect results consistent with 2009. In the first of these censuses, Chinook were typically observed at higher density in treated pools, but not in later weeks. Steelhead density was higher in untreated microhabitats, similar to 2009, but was highly variable.

The elevated density of juvenile Chinook in treated microhabitats appears to be associated with a strong response to the increased water depth created by placed structures. Over the last three years, juvenile Chinook were more likely to be found in areas with the added structures, especially in 2009 (Figure 3). Juvenile steelhead, were also more likely to be found in areas with added structures in 2009 and 2011, but not in 2010. Steelhead are highly variable in their habitat use (Figure 4).

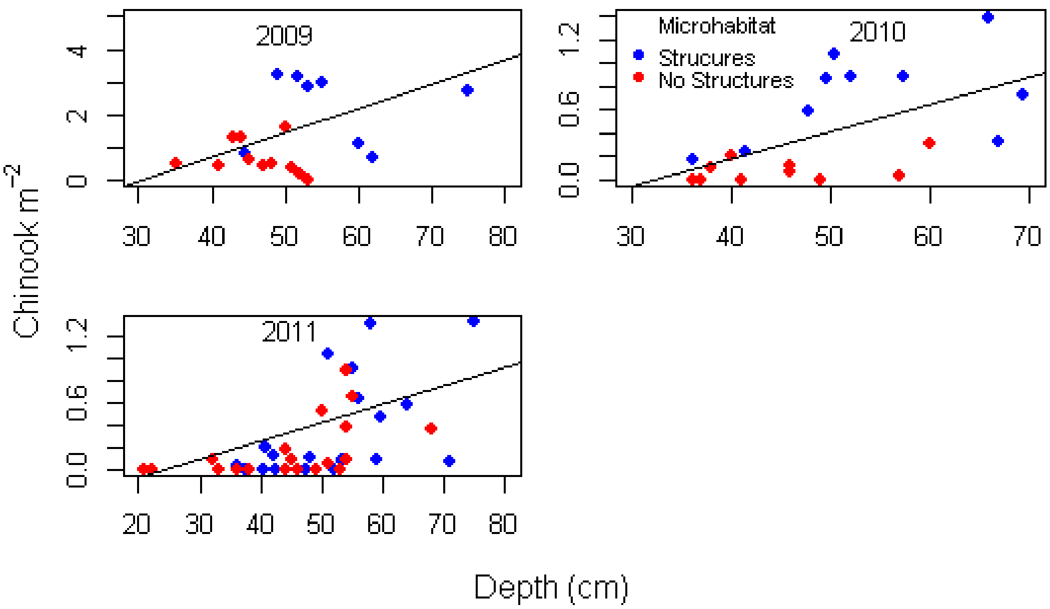


Figure 3. The density of Chinook salmon at microhabitat structures within the treated reach versus the control reach during three years of sampling.

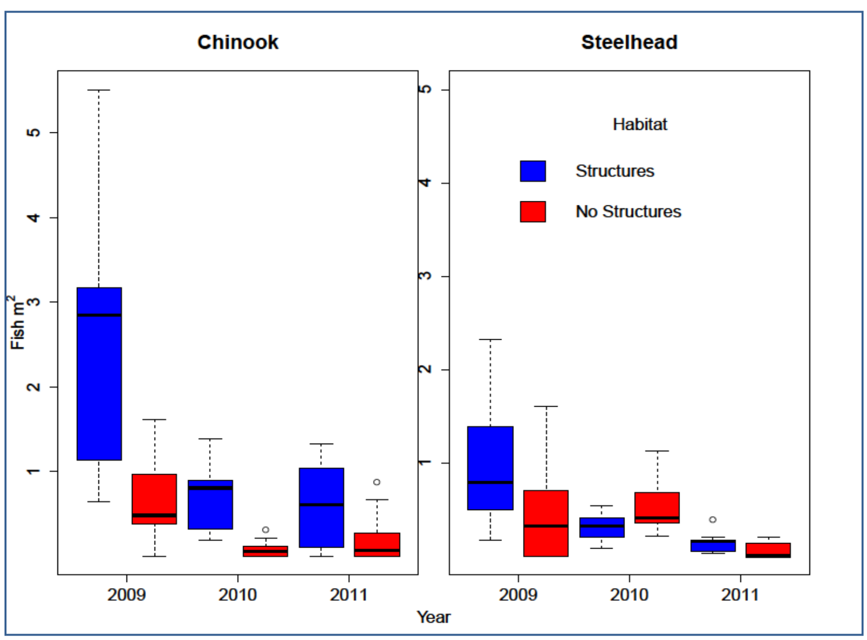


Figure 4. The density of Steelhead at microhabitat structures within the treated reach versus the control reach during three years of sampling showing high variability.

Polivka (2011) took his investigation a step further in 2009 by examining behavior and growth in pools with and without treatment. His interest was to determine whether the observation of higher density at microhabitats with structures was truly a benefit to fish or whether this was an artifact of fish movement. In a short term (24 hr) mark-recapture study, both Chinook and steelhead tended to be recaptured in the same pools, where they were marked, more frequently when those pools were treated with structures compared with untreated microhabitats **(Figure 5)**. The higher affinity to microhabitat associated with the structure placement in the treated reach provides a short-term preference and appears highly beneficial for fish.

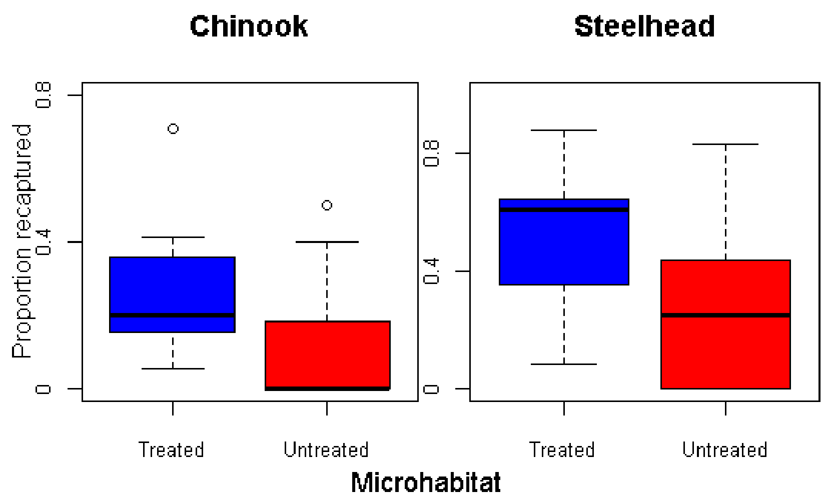


Figure 5. In 2009, fish were proportionally more often recaptured in habitat features within the treated reach of Milne than the control reach indicating a higher affinity for treated microhabitat features.

During both 2009 and 2010 field season, Polivka (2011) measured growth across the short season during which the survey crew were able to sample, mark and recapture both steelhead and Chinook. Due to the pattern of seasonal variation in fish density, in which Chinook density declines substantially during late August and early September, too few recaptures were obtained in 2010 to identify any difference in growth among Chinook. However, steelhead, despite being at lower density at structures than at untreated sites, had higher growth rates at the structures. This strongly suggests that growth along with density could be used as an indicator for fish response to instream habitat restoration (Polivka, 2011). Growth patterns are still under analysis for data collected in both years.

Summary

Numerical Abundance

The early-season (July) microhabitat-scale densities of both Chinook and steelhead were higher at structures compared with randomly selected microhabitats within that study segment and all other study segments. Later in the season (mid-September), structures were not a reliable predictor of microhabitat-scale fish density.

Habitat Affinity and Growth

Both Chinook and steelhead showed higher proportion of fish recaptured after 24 hours in treated stream pool than in untreated. Due to the low number of Chinook recaptures in untreated habitat, the study team was unable to make a comparative estimate of growth. For steelhead, however, fish recaptured in each habitat type showed higher growth in treated habitat over all recapture intervals compared with untreated habitat.

References Cited

Moberg, J., and M. B. Ward. 2009. 2008 Synthesis Report for Data Collected under the ISEMP Effectiveness Monitoring Program in the Entiat River Subbasin. Prepared *for* Bonneville Power Administration, Integrated Status and Effectiveness Monitoring Program.

Polivka, K.* 2010. Population Ecology and Effectiveness Monitoring of Small-Scale Instream Habitat Restoration Structures in the Entiat River. In Upper Columbia Regional Technical Team 2010 analysis workshop synthesis report. Edited by Ward, M.B., and J. Morgan and C. Baldwin. UCRTT and Terraqua, Inc. Wenatchee, WA: UCSRB, pp. 51-54.

Polivka, K.* 2011. Summary Brief – Small Scale Monitoring of In-Stream Habitat Restoration in the Entiat River. Submitted to ISEMP and Bonneville Power Administration.

Polivka, K.* 2012. Restoring Fish Habitat in the Entiat River. Presented to the Entiat Habitat Subcommittee, April 19, 2012.

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